Mathcad sheet to derive U for SW with GBN

$f(i) := 1 + (i - 1)\cdot K$ Number of packets to be sent for try i

$N := \sum_{i=1}^{\infty} \left[f(i)\cdot p^{i-1}\cdot(1-p) \right]$ We need to solve for N symbollically

$N := (1-K)(1-p)\cdot \sum_{i=1}^{\infty} p^{i-1} + K\cdot(1-p)\cdot \sum_{i=1}^{\infty} \left(i\cdot p^{i-1} \right)$ Step #1 by hand

$$N \rightarrow \begin{cases} (K-1)\cdot(p-1)\cdot\infty - \frac{K}{p-1} & \text{if } 1 \le p \\ 1 - \frac{K}{p-1} - K & \text{if } p \ne 1 \wedge |p| < 1 \end{cases}$$ Here is our result

$$U := \frac{W\cdot t_{fr}}{\left(1 - \frac{K}{p-1} - K\right)\cdot\left(t_{fr} + 2\cdot t_{pr}\right)}$$ So we now have this, but what is K

For W too small to fill the pipe K = W. We simplify the above to get:

$$U := \frac{W\cdot(1-p)\cdot t_{fr}}{\left(t_{fr} + 2\cdot t_{pr}\right)\cdot(W\cdot p + 1 - p)}$$ Simplified for case of W too small to fill piple

For W large enough to fille the pipe K = t_fr / (t_fr + 2t_pr). We then get:

$$U := \frac{1}{\left[1 - \frac{\left(\frac{t_{fr} + 2\cdot t_{pr}}{t_{fr}}\right)}{p-1} - \left(\frac{t_{fr} + 2\cdot t_{pr}}{t_{fr}}\right)\right]}$$

$$U := \frac{(1-p)\cdot t_{fr}}{2\cdot p\cdot t_{pr} + t_{fr}}$$
